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(71) Applicant
Parker Hannifin Corporation, 17235 Euclid Avenue, Cleveland, Ohio 44112, United States of America
(72) Inventors
Donald Edward Washkewicz,
Wayne Scott Busdiecker
(74) Agent
D. Young & Co.

(54) **Hose Construction**

(57) A high strength flexible hose for conveying fluids under pressure wherein the hose includes a synthetic thermoplastic polymeric core tube (12), one or more layers of wire reinforcement material (14, 18), and an outer sheath of thermoplastic elastomeric material (16) mechanically interlocked with the wire reinforcement material.

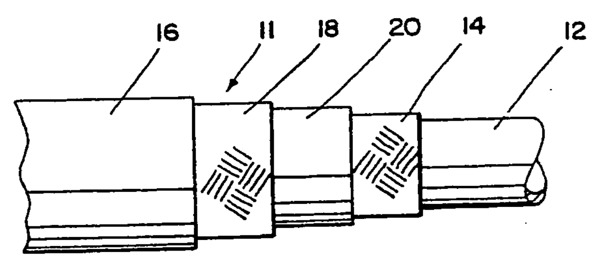

Fig. 2

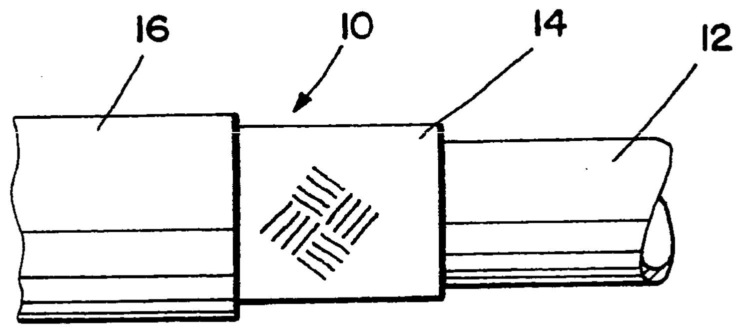

Fig. 1

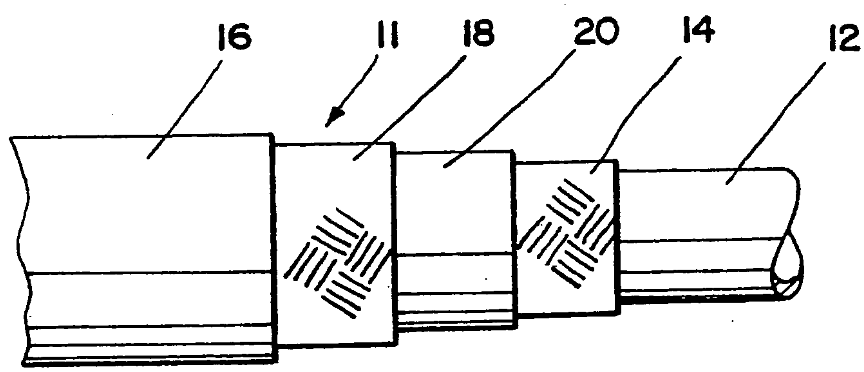

Fig. 2

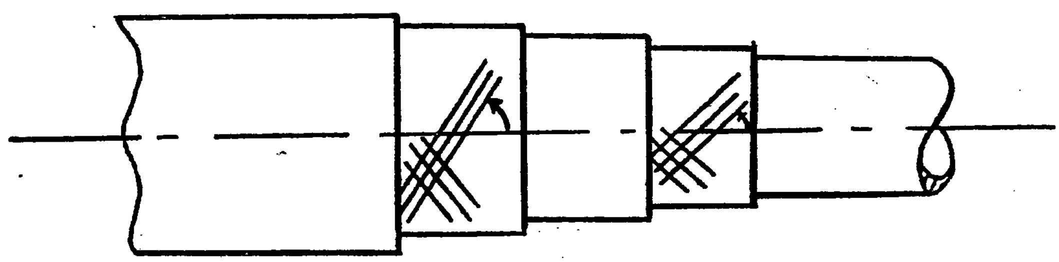

FIG. 3

SPECIFICATION

Hose Construction

This invention relates to flexible composite hose.

Flexible hoses made of elastomeric, rubber, or plastics materials usually require reinforcement by yarns such as braided, spirally wound, or knitted rayon, Dacron, nylon, or the like, when the hoses are to be used for conveying fluids under pressure. For small diameter hoses, a layer of the aforementioned reinforcement yarn may be sufficient to give the hose the required burst strength and kink resistance. However, for larger diameter hoses, a layer of metal wire reinforcement may be required in addition to the layer of reinforcement yarn to make the hose relatively kink resistant. However, the use of an elastomeric, plastic, or rubber material for the outer sheath of the hose in conjunction with the metal wire reinforcement sometimes results in corrosion of the wire because these materials have a relatively high moisture vapor transmission rate. Such corrosion may eventually cause wire failure. In addition, these materials have a low resistance to abrasion which minimizes the amount of damage the outer sheath can withstand from an external source before the sheath and possibly the wire reinforcement are damaged.

Because of the problem of moisture permeation into the hose structure resulting in corrosion of the metal reinforcement material and the lack of abrasion resistance of the outer sheath, it has become desirable to develop a hose construction which is resistant to external abrasion and wherein the wire reinforcement is protected from corrosion.

The present invention provides a solution to the aforementioned problems of wire reinforcement corrosion and the lack of abrasion resistance of the outer sheath. This is accomplished by using a thermoplastic elastomeric material for the outer sheath. Preferably this material is pressure extruded over the wire reinforcement to form a mechanical interlock therewith. Thermoplastic elastomeric materials are generally flexible and generally have a low moisture vapor transmission rate preventing corrosion of the wire reinforcement and are abrasion resistant, minimizing abrading at the wire-outer sheath interface and abrasion damage to the outer sheath by external sources.

The invention thus provides a high burst strength flexible composite hose comprising a core tube of thermoplastic polymeric material, one or more layers of metal wire reinforcing material disposed about said core tube, and a sheath of thermoplastic elastomeric material disposed about said one or more layers of metal wire reinforcing material.

One embodiment of the invention uses a thermoplastic polymeric core tube, one layer of wire reinforcement material disposed about the core tube, and an outer sheath of thermoplastic elastomeric material. Another embodiment of the invention substitutes two layers of wire reinforcement material separated by a layer of buffer material for the single layer of wire reinforcement material.

Preferred embodiments of the invention will now be described with reference to the accompanying drawings in which:—

Figure 1 is a side view, broken away in successive structural layers of a hose made in accordance with the present invention and having one layer of wire reinforcement material.

Figure 2 is a side view, broken away in successive structural layers of a hose in accordance with the present invention and having two layers of wire reinforcement material separated by a layer of buffer material.

Figure 3 is a view similar to that of Figure 2 showing different winding angles of two reinforcement layers.

Referring now to the drawings, Figure 1 illustrates a hose 10 having a core tube 12 of thermoplastic polymeric material, a layer 14 of wire reinforcement material about the core tube, and an outer sheath 16 of thermoplastic elastomeric material.

The core tube 12 is formed from any of the well-known thermoplastic polymers used in the hose industry to produce reinforced hose, such as Nylon 6/66, Nylon 11, Hytrel, polyurethane, or the like. The selection of the particular material used for the core tube will depend upon the end use and the properties desired of the hose.

Reinforcement layer 14 is formed from any typical metal wire used in the hose industry, such as carbon steel, copper, stainless steel, brass plated steel, or aluminum. The wire selected may be applied as a braid, as shown in Figure 1, or may be spirally wound or knitted about core tube 12. (It should be noted that throughout this description when a reinforcement layer is spirally wound, one strand of wire is helically wound on the core tube in one direction and another strand is helically wound over the first strand in the opposite direction and the two strands together comprise one layer of reinforcement). When the wire is applied as a braid or is spirally wound on the core tube, it is oriented at an angle of between 48° and 58° with respect to the longitudinal axis of the core tube. During the application of the wire to the tube, tension may be applied to the wire so that it firmly contacts the tube. Typically, an adhesive is not required to bond the wire to the tube because the tension of the wire provides a sufficient mechanical lock therebetween.

In the preferred embodiment of the invention, reinforcement layer 14 is comprised of brass plated steel wire having a diameter between 0.006 inch and 0.022 inch and having a tensile strength of about 320,000 psi. This brass plated steel wire is applied as a braid at a neutral angle of 54° 44′ about core tube 12. A tension of from 4 to 30 lbs. is applied to the wire as it is being braided about core tube 12 so that the wire firmly contacts the core tube thus eliminating the need for an adhesive between the tube and the

reinforcement layer. In addition, the brass plated steel wire is applied so as to cover between 75 to 100 per cent of the core tube thus providing strength, kink resistance, and resistance to burn through and/or cut through to the resulting hose structure.

The outer sheath 16 is comprised of a pressure extruded jacket of a thermoplastic elastomer (TPE). Suitable properties for the thermoplastic polymer include:—

1) Tensile strength of about 2500 psi and about 1400 psi at 25°C and 100°C respectively.

2) 100% modulus of about 1350 psi and about 650 psi respectively at these temperatures.

3) Melting temperature about 165°C.

Other less important properties include

4) A coefficient of thermal expansion of about 8.6×10^{-5} inch/inch/°C.

5) A shore hardness of about 93A and about 43D.

6) A specific gravity of 0.99.

7) A tensile set of 42% at room temperature (ASTM D412, 100% elongation).

The polymer desirably has one or more of these properties and it is envisaged that the numerical figures given may be varied by, say ± 10%.

Outer sheath 16 is pressure extruded about wire reinforcement layer 14 so as to be pressed into the interstices existing in reinforcement layer 14 forming a mechanical interlock with the reinforcing wire. Because the sheath is pressure extruded, the mechanical interlock between the sheath and the wire reinforcement is sufficiently strong to eliminate the need for an adhesive therebetween. This mechanical interlock also maintains the wire in its proper position even though it may move slightly with flexing of the hose thus reducing abrading at the wire-outer sheath interface. In addition, this mechanical interlock improves retention of the fitting that is subsequently attached to the hose inasmuch as it prevents the sheath from breaking away from the reinforcement layer during the swaging process. Such breaking away of the sheath will cause the sheath to bulge during subsequent hose pressurization and/or to wrinkle during hose flexing.

Another embodiment of the invention is shown in Figure 2. This embodiment differs from that shown in Figure 1 in that is has a second layer of wire reinforcement material which is disposed about the first layer of wire reinforcement material and is separated therefrom by means of an insulating layer. Those hose components which are similar to those previously disclosed with respect to Figure 1 are given like numerals and will not be described further.

In this embodiment of the invention, hose 11 has a second layer 18 of wire reinforcement material disposed about wire reinforcement layer 16 and isolated therefrom by means of buffer layer 20. Second wire reinforcement layer 18 is similar to wire reinforcement layer 14 in that it may be formed from any typical metal wire used in the hose industry, such as carbon steel, copper, stainless steel, brass plated steel, or aluminum, and may be applied as a braid or may be spirally wound or knitted about reinforcement layer 14. As is the case with wire reinforcement layer 14, when the wire comprising second reinforcement layer 18 is applied as a braid or is spirally wound, it is usually oriented at an angle of between 48° and 58° with respect to the longitudinal axis of the core tube. A tension may also be applied to the wire comprising second reinforcement layer 18 during application of the wire so that it will firmly engage buffer layer 20 and reinforcement layer 14.

Buffer layer 20 may be formed from a synthetic polymeric material, such as Nylon 6/66, Nylon 11, Hytrel, polyurethane, or the like, or it may be formed from cured, semi-cured or uncured elastomeric material, such as Hypalon, chlorosulfonated polyethylene, nitrile, neoprene, or the like, or it may be comprised of an overbraid of fabric such as rayon, Dacron, or the like, or it may be comprised of woven fabric or elastomerically calendered woven fabric such as rayon, Dacron, or the like. If the material selected for buffer layer 20 is a polymer or an elastomer, it may be extruded or applied as a strip about reinforcement layer 14. In contrast, if the material is an overbraid of fabric it may either be braided, spirally wound, or knitted about layer 14. Furthermore, if the material is a woven fabric or an elastomerically calendered woven fabric it may be circumferentially wrapped or longitudinally laid about reinforcement layer 14. In any event, if both reinforcement layers 14 and 18 or either of them are spirally wound, buffer material may also be provided between the complementary spiral turns in each layer.

In the preferred embodiment of the invention, reinforcement layers 14 and 18 are both comprised of brass plated steel wire having a diameter between 0.006 inch and 0.022 inch and having a tensile strength of about 320,000 psi. As with the previously disclosed preferred embodiment for the single wire reinforced hose, the brass plated steel wire comprising reinforcement layer 14 is applied as a braid at a neutral angle of 54° 44′ about core tube 12, however, second reinforcement layer 18 and any succeeding reinforcement layers may be applied at the neutral angle of 54° 44′ or at an angle slightly greater than 54° 44′ to efficiently load the succeeding reinforcement layers. A tension of from 4 to 30 lbs. is applied to the wire comprising both reinforcement layers 14 and 18 as they are being braided so that reinforcement layer 14 firmly contacts core tube 12 eliminating the need for an adhesive therebetween, and so that each succeeding reinforcement layer contacts buffer layer 20 and engages the reinforcement layer about which it is disposed. In addition, the brass plated steel wire is applied so that each braid covers between 75 to 100 per cent of the preceding adjacent reinforcement layer or core tube.

Buffer layer 20 in the preferred embodiment of

the invention is formed from cured neoprene which is applied as a thin strip that is longitudinally laid on layer 14 prior to the braiding of wire reinforcement layer 18 about layer 14. This neoprene strip acts as an insulating medium between wire reinforcement layers 14 and 18 allowing relative longitudinal non-abrasive movement therebetween making the resulting hose structure quite flexible. In addition, since the neoprene buffer material acts as an insulating medium, it also distributes internal stresses within the hose minimizing wire fatigue.

In the preferred embodiment of the invention, thermoplastic elastomeric outer sheath 16 is pressure extruded about wire reinforcement layer 18 forming a mechanical interlock therewith. This mechanical interlock provides the multiple wire reinforced hose with all of the aforementioned advantages that exist for a single wire reinforced hose structure. Regardless of whether a single of multiple wire reinforced construction is used, the use of a thermoplastic elastomer for the outer sheath provides numerous other advantages. For example, thermoplastic elastomeric material is generally more flexible than nylon, polyester, Hytrel, or polyurethane, which are typical outer sheath materials used in the prior art, and thus the resulting hose structure is quite flexible. In addition, thermoplastic elastomeric material exhibits resistance to hot water and phosphate ester hydraulic fluids permitting the resulting hose structure to be used in an environment where it comes into contact with hot water and/or these types of hydraulic fluids without any adverse effects. Also thermoplastic elastomeric material is very abrasion resistant, and thus an outer sheath formed therefrom protects the wire reinforcement from damage caused by external abrasion. And lastly, thermoplastic elastomeric material has a low moisture vapor transmission rate thus protecting the wire reinforcement layers from corrosion.

In the preferred embodiment of the invention, the outer sheath 16 is preferably a thermoplastic elastomeric material sold under the trade mark Santoprene and available from the Monsanto Company, 260 Springside Drive, Akron, Ohio 44313. This material is suitable for pressure extrusion and has a coefficient of thermal expansion of about 8.6×10^{-5} inch/inch/°C, and a melting temperature fo 165°C. The material has a tensile strength of 2500 psi and 1400 psi at 25°C and 100°C respectively and a 100% modulus of 1350 psi and 650 psi, respectively at these temperatures. Further properties which could be characteristic of the material include Shore hardnesses of 93A and 43D and a specific gravity of 0.99. A key characteristic of this material is its recovery after stresses are applied and a set figure of 42% is indicative of its tensile set at room temperature conditions (ASTM D 412, 100% elongation). Compression set data indicates, particularly at elevated temperatures, a similar, excellent resistance to compression set and the material exhibits high resistance to creep and coldflow.

Variations of the present invention will be apparent to those having ordinary skill in the art and the invention is limited only by the spirit and scope of the following claims.

Claims

1. A high burst strength flexible composite hose comprising a core tube of thermoplastic polymeric material, one or more layers of metal wire reinforcing material disposed about said core tube, and a sheath of thermoplastic elastomeric material disposed about said one or more layers of metal wire reinforcing material.

2. A hose as defined in claim 1 wherein said sheath of thermoplastic elastomeric material is pressure extruded over said one or more layers of metal wire reinforcing material forming a mechanical interlock with said metal wire reinforcing material.

3. A hose as defined in claim 1 or 2 wherein said thermoplastic elastomeric material has a high resistance to abrasion and a low vapor transmission rate.

4. A hose as defined in any preceding claims which has one or more of the following properties:—

1) Tensile strength of about 2500 psi and about 1400 psi at 25°C and 100°C respectively.

2) 100% modulus of about 1350 psi and about 650 psi respectively at these temperatures.

3) Melting temperature about 165°C.

5. A hose as defined in any preceding claim which has two or more layers of metal wire reinforcing material disposed about said core tube and a layer of buffer material between adjacent layers of said two or more layers of metal wire reinforcing material, said sheath of thermoplastic elastomeric material being disposed about the outermost layer of said two or more layers of metal wire reinforcing material.

6. A hose as defined in claim 5 wherein said buffer material insulates each of said two or more layers of metal wire reinforcing material from the adjacent layer of metal wire reinforcing material allowing relative longitudinal movement therebetween.

7. A hose as defined in claim 5 or 6 wherein one or more layers of said metal wire reinforcing material is spirally wound about said core tube and a layer of said buffer material is provided between complementary turns of each of said spirally wound layers of said metal wire reinforcing material.

8. A hose as defined in claim 5, 6 or 7 wherein said buffer material is neoprene.

9. A hose as defined in any one of claims 4 to 8 wherein said two or more layers of metal wire reinforcing material are applied at an angle with respect to the longitudinal axis of said core tube, said angle increasing for each succeeding layer of metal wire-reinforcing material.

10. A hose substantially as hereinbefore described with reference to Figure 1 or Figure 2 of the drawing.

New Claims or Amendments to Claims filed on 21 March 1979
Superseded Claims 4.

New or Amended Claims:—

4. A hose as defined in any preceding claim wherein the sheath material has one or more of the following properti s:—
about 1400 psi at 25°C and 100°C respectively.

2) 100% modulus of about 1350 psi and about 650 psi respectively at these temperatures.

3) Melting temperature about 165°C.

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